

What is claimed is:

1. A vehicle surroundings monitoring apparatus including:

a radar for scanningly irradiating electromagnetic waves over a predetermined angular range around a subject vehicle on which said apparatus is mounted, detecting the electromagnetic waves reflected from objects lying around said subject vehicle, and outputting a plurality of directions of scanning irradiation and detected distances from said subject vehicle to said objects in the respective directions of scanning irradiation; and

a recognition unit for outputting, based on the detection results of said radar, a relative position and a relative speed, or a rate of change of the relative position, of each of said objects lying around said subject vehicle with respect to said subject vehicle;

said recognition unit comprising:

a detection points data storage section for storing therein whether or not detection points data in the form of a data pair comprising a direction of scanning irradiation and a detected distance in that direction output by said radar exists in each of $M \times N$ small regions into which X, Y coordinates with an X axis being set in a widthwise direction of said subject vehicle and a Y axis being set in a running direction of said subject vehicle are divided, in a two-dimensional array including a plurality of elements corresponding to the small regions, respectively; and

an object detection section for performing arithmetic operations of multiplication and summation of the respective elements of said two-dimensional array representative of the presence or absence of the detection points data stored in said detection points data storage section while sequentially scanning a mask of a two-dimensional array comprising $J \times K$ ($J < N$, $K < M$) elements, and determining, based on the results of the arithmetic operations, attributes such as positions, sizes, etc., of said objects lying

around said subject vehicle.

2. The vehicle surroundings monitoring apparatus according to claim 1, wherein said detection points data storage section comprises:
 - a stop detection points determiner for determining, by the use of information about the subject vehicle, whether each of the detection points data is a piece of stop detection points data representative of the data of a stop or stationary object detected, or a piece of moving points detection data representative of an object other than the stationary object, i.e., a moving object;
 - a stop detection points data storage section for storing, based on the results of determination of said stop detection points determiner, the presence or absence of stop detection points data in each of MxN small regions into which X, Y coordinates with an X axis being set in a widthwise direction of said subject vehicle and a Y axis being set in a running direction of said subject vehicle are divided, in a two-dimensional array comprising a plurality of elements corresponding to the small regions, respectively; and
 - a moving detection points data storage section for storing, based on the results of determination of said stop detection points determiner, the presence or absence of moving detection points data in each of the MxN small regions into which X, Y coordinates with an X axis being set in a widthwise direction of said subject vehicle and a Y axis being set in a running direction of said subject vehicle are divided, in a two-dimensional array comprising a plurality of elements corresponding to the small regions, respectively; and
- wherein said object detection section comprises:
 - a stationary object detector for performing arithmetic operations of multiplication and summation of the respective elements of said two-dimensional array representative of the presence or absence of the stop

detection points data stored in said stop detection points data storage section while sequentially scanning a mask of a two-dimensional array comprising $J \times K$ ($J < N$, $K < M$) elements, and determining, based on the results of the arithmetic operations, attributes such as positions, sizes, etc., of stationary objects lying around said subject vehicle; and

a moving object detector for performing arithmetic operations of multiplication and summation of the respective elements of said two-dimensional array representative of the presence or absence of the moving detection points data stored in said moving detection points data storage section while sequentially scanning a mask of a two-dimensional array comprising $J \times K$ ($J < N$, $K < M$) elements, and determining, based on the results of the arithmetic operations, attributes such as positions, sizes, etc., of moving objects lying around said subject vehicle.

3. The vehicle surroundings monitoring apparatus according to claim 1,
wherein said recognition section further comprises a column detection points determiner for determining whether the respective detection points data are column detection points data representative of data arranged in the running direction of said subject vehicle, and
wherein said detection points data storage section does not use the column detection points data in its processing.

4. The vehicle surroundings monitoring apparatus according to claim 2,
wherein said recognition section further comprises a column detection points determiner for determining whether the respective detection points data are column detection points data representative of data arranged in the running direction of said subject vehicle, and
wherein said stop detection points data storage section or said moving detection points data storage section does not use the column

detection points data in their processing.

5. The vehicle surroundings monitoring apparatus according to claim 1,
wherein said recognition unit further comprises a curved road
detection points determiner for determining whether the respective detection
points data are curved road detection points data representative of data
arranged along a curved road, and
wherein said detection points data storage section does not use the
curved road detection points data in its processing.

6. The vehicle surroundings monitoring apparatus according to claim 2,
wherein said recognition unit further comprises a curved road
detection points determiner for determining whether the respective detection
points data are curved road detection points data representative of data
arranged along a curved road, and
wherein said stop detection points data storage section or said
moving detection points data storage section does not use the curved road
detection points data in their processing.

7. A vehicle surroundings monitoring apparatus comprising:
a radar for scanningly irradiating electromagnetic waves over a
predetermined angular range around a subject vehicle on which said
apparatus is mounted, detecting the electromagnetic waves reflected from
objects lying around said subject vehicle, and outputting detected distances
from said subject vehicle to said objects lying around said subject vehicle and
directions of said objects from said subject vehicle; and
a recognition unit for outputting, based on the detection results of
said radar, a relative position and a relative speed, or a rate of change of the
relative position, of each of said objects lying around said subject vehicle with

respect to said subject vehicle;

said recognition unit comprising:

an object detection section for detecting positions of said objects by using detection points data obtained by said radar, and calculating object positional data representative of the positional data of said objects;

an object position estimator for estimating a position of each object detected in the past which should currently be detected, based on the past positional data of that object;

a window setter for setting a prescribed window in such a manner as to surround the estimated position of each object output by said object position estimator; and

an object tracker for determining the current positional data of an object by using the detection points data contained in the window set by said window setter, and calculating a relative speed of that object to said subject vehicle by using the positional data of that object detected in the past.

8. The vehicle surroundings monitoring apparatus according to claim 7,

wherein said recognition unit further comprises a stop detection points determiner for determining, by the use of information about said subject vehicle, whether each of the detection points data is a piece of stop detection points data representative of the data of a stopped object detected, or a piece of moving points detection data representative of an object other than a stopped object, and

wherein said object tracker calculates, based on the determination results of said stop detection points determiner, a current positional data of an object, by using the stop detection points data contained in the window set by said window setter when a difference between a relative speed of that object with respect to said subject vehicle detected in the past and a speed of said subject vehicle detected in the past is less than a prescribed value, but

by using the moving detection points data contained in the set window when a difference between a relative speed of that object with respect to said subject vehicle and a speed of said subject vehicle both detected in the past is equal to or greater than the prescribed value, and said object tracker also calculates a current relative speed of that object with respect to said subject vehicle by using the current and past positional data of that object.

9. The vehicle surroundings monitoring apparatus according to claim 7, wherein said object detection section does not use the detection points data which were used to calculate the object positional data in the current processing of said object tracker.
10. The vehicle surroundings monitoring apparatus according to claim 7, wherein said recognition section further comprises a column detection points determiner for determining whether the respective detection points data are column detection points data representative of data arranged in the running direction of said subject vehicle, and wherein said object tracker does not use the column detection points data in its processing based on the detection results of said column detection points determiner.
11. The vehicle surroundings monitoring apparatus according to claim 7, wherein said recognition unit further comprises a curved road detection points determiner for determining whether the respective detection points data are curved road detection points data representative of data arranged along a curved road, and wherein said object tracker does not use the curved road detection points data in its processing based on the detection results of said curved road detection points determiner.